Mitigating Anthropogenic CCfuture of carbon cycle in “overshoot” worlds

Nebojša Nakićenović
Vienna University of Technology
International Institute for Applied Systems Analysis
naki@iiasa.ac.at

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A Proposal for a New Community Scenarios

Nebojša Nakićenović
Vienna University of Technology
International Institute for Applied Systems Analysis
naki@iiasa.ac.at

New Integrated Assessment Approach

Forward approach: start with socio-economic variables

Reverse approach: start with stabilization scenario concentrations
Initial Scenarios
Few baselines (2) – few stabilization targets (3)
All modeling groups

Sensitivity Scenarios with specific research focus
Selected group of models for each topic
Baseline Uncertainty
Interim-targets and Overshoot
Limited regional participation
Technology (e.g., limited portfolio)

Climate and ESS Models
Baseline and stabilization climate projections
Carbon fluxes and other feedback

Source: After Keywan Riahi, 2006
2030 Energy Goal

- Universal Access to Modern Energy
- Double Energy Efficiency Improvement
- Double Renewable Share in Final Energy

Aspirational & Ambitious but Achievable
Energy savings (efficiency, conservation, and behavior)
~40% improvement by 2030

~55% renewables by 2030

Nuclear phase-out (policy)

Source: Riahi et al, 2012
Energy savings (efficiency, conservation, and behavior)
- ~40% improvement by 2030
- ~30% renewables by 2030

Source: Riahi et al, 2012
Human Perturbation of the Global Carbon Budget

Global Carbon Project 2011; Le Quéré et al. 2009 & 2012, Nature G; Canadell et al. 2007, PNAS
Historical Carbon Fluxes

Land-Use Change incorporated into Terrestrial Pool

Historical Data: Global Carbon Project, 2010; Le Quere et al., 2012
Historical Carbon Fluxes

Historical Data: Global Carbon Project, 2010; Le Quere et al., 2012
Historical Carbon Fluxes

Source

Sink

Carbon flux [PgC/yr]

atmosphere
terrestrial
ocean
emissions

1850 1900 1950 2000

Historical Data: Global Carbon Project, 2010; Le Quere et al., 2012

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IIASA RCP8.5

RCP Data: http://tntcat.iiasa.ac.at:8787/RcpDb/
Historical Data: Global Carbon Project, 2010; Le Quere et al., 2012
Analysis of CMIP5 RCP Data by Chris Jones, Jones et al., 2013

Historical Data: Global Carbon Project, 2010; Le Quere et al., 2012
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Historical Data: Global Carbon Project, 2010; Le Quere et al., 2012
no CCS, no Nuclear

Carbon flux [PgC/yr]

1850 1900 1950 2000 2050 2100

Cumulative emissions since 1850 [PgC]

Source

Sink

Nakicenovic and Rogner, 2013, Global Energy Assessment, 2012

Historical Data: Global Carbon Project, 2010; Le Quere et al., 2012
no CCS, no Nuclear

Source

Sink

Carbon flux [PgC/yr]

Cumulative emissions since 1850 [PgC]

-15 -10 -5 0 5 10 15

atmosphere terrestrial ocean emissions
carbon balance since 1850 additional carbon in the atmosphere since 1850

Nakicenovic and Rogner, 2013, Global Energy Assessment, 2012
Historical Data: Global Carbon Project, 2010; Le Quere et al., 2012
Lim. Bioenergy, lim. Intermittent REN

Carbon flux [PgC/yr]

Source

Sink

Cumulative emissions since 1850 [PgC]

-1500 -1000 -500 0 250 500 750 1000

-15 -10 -5 0 5 10 15

1850 1900 1950 2000 2050 2100

Atmosphere
Terrestrial
Ocean
Emissions

carbon balance since 1850
additional carbon in the atmosphere since 1850

Nakicenovic and Rogner, 2013, Global Energy Assessment, 2012
Historical Data: Global Carbon Project, 2010; Le Quere et al., 2012
Source
Limited Bioenergy
Bio-CCS – "negative CO₂"

Sink

Cumulative emissions since 1850 [PgC]

-1000
-750
-500
-250
0
250
500
750
1000

Carbon flux [PgC/yr]

-15
-10
-5
0
5
10
15

1850 1900 1950 2000 2050 2100

atmosphere terrestrial ocean emissions

carbon balance since 1850
additional carbon in the atmosphere since 1850

Nakicenovic and Rogner, 2013, Global Energy Assessment, 2012
Historical Data: Global Carbon Project, 2010; Le Quere et al., 2012
Unified (re-ordered) SSP scheme

SSPs aim at covering the range of plausible combinations of mitigative and adaptive capacity (in the baseline).

![Diagram showing SSPs across a spectrum of baseline emission, decreasing mitigation capacity, and increasing adaptive capacity and sensitivity. The SSPs are ordered as follows: SSP 1, SSP 2, SSP 3, SSP 4, SSP 5.](image-url)
Adaptation Policies Mitigation
Mitigation

Adaptation

Policies

90°
“Granger’s Problem”
Greatest achievement is “community building”
A small scenario set needed by most users
High and low baseline and stabilization (4-6)
Creative and simple meta-narrative and logic
Pertinent and plausible description of the “library”
How can communities use and select scenarios
We offer to host a brainstorming meeting at IIASA to work on possible interpretative architectures
Global CO₂ Emissions

- Peak by 2020
- Reductions of 35-75% by 2050
- Almost zero or negative in the long term
CO₂ Emissions (World)

Source: van Vuuren et al, 2009
CO$_2$ Emissions (World)

- Baselines
- RCP 2.6
- RCP 4.5
- RCP 6.0
- RCP 8.5

Source: Riahi et al, 2010

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Previous IPCC Scenarios and Future Outlook


Six IS92 scenarios  Evaluation Scenarios  TAR mitigation scenarios  RCPs  AR5 RCPs/SSPs

Four SA90 scenarios  Panel decision new scenarios  AR4 assessment of stabilization scenarios

Special Report Emission Scenarios (SRES)

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)